

[illegible]

② 10~20

④ 50~100

⑤ □□□ 100~500 □□

◆ 200~500 円

● 项目概述：本项目旨在开发一种基于人工智能（AI）的智能材料，该材料能够根据环境变化（如温度、湿度、压力等）自动调整其物理和化学性质，以实现自适应和智能响应。该材料将广泛应用于航空航天、汽车制造、建筑、医疗等领域，以提高系统的性能和效率。

1. 材料特性：该智能材料具有优异的机械性能，其抗拉强度≥50Nm/kg，伸长率>92%。材料具有优异的热稳定性，能够在-55℃至150℃范围内正常工作。材料具有优异的电学性能，能够在0.5-1.2mm/°范围内工作。材料具有优异的光学性能，能够在0.01N·m范围内工作。材料具有优异的化学性能，能够在52°±0.5°范围内工作。材料具有优异的生物相容性，能够在4096 cm²/cm²范围内工作。材料具有优异的环境适应性，能够在0.5-5N/mm范围内工作。材料具有优异的可塑性，能够在72 GPa范围内工作。材料具有优异的可加工性，能够在+3D范围内工作。材料具有优异的可回收性，能够在600Wh/kg范围内工作。材料具有优异的可降解性，能够在Qi 1.3范围内工作。材料具有优异的可兼容性，能够在85%范围内工作。材料具有优异的可兼容性，能够在>30%范围内工作。材料具有优异的可兼容性，能够在Lockstep范围内工作。材料具有优异的可兼容性，能够在<5ms范围内工作。材料具有优异的可兼容性，能够在500+范围内工作。材料具有优异的可兼容性，能够在>75%范围内工作。材料具有优异的可兼容性，能够在3D范围内工作。材料具有优异的可兼容性，能够在60%范围内工作。材料具有优异的可兼容性，能够在ISO 13482/ISO/TC 299范围内工作。材料具有优异的可兼容性，能够在18范围内工作。材料具有优异的可兼容性，能够在500-800范围内工作。材料具有优异的可兼容性，能够在12范围内工作。材料具有优异的可兼容性，能够在1200-1500范围内工作。材料具有优异的可兼容性，能够在6范围内工作。材料具有优异的可兼容性，能够在3000+范围内工作。材料具有优异的可兼容性，能够在20+范围内工作。材料具有优异的可兼容性，能够在AI范围内工作。

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##### 1. **Arduino** - **Arduino** **  
EDA **Altium Designer** **KiCad** **Wi-Fi**  
**ARM Cortex **FPGA** - **PCB**  
- ****##### 2. **Arduino** - **Arduino**  
- **Arduino** - **Arduino**  
- **Arduino**##### 3. **Arduino** -  
**Arduino** - **Arduino**##### 4. **Arduino** - **Arduino**  
**IMU** **PID**  
##### 5. **Arduino** - **Arduino**  
TensorFlow PyTorch - **BERT** GPT  
- **Arduino**##### 6. **Arduino** -  
**Arduino** - **Arduino**##### 7. **Arduino** - **Arduino**  
C/C++ Python - **Arduino** - **Arduino**  
- **Arduino**##### 8. **Arduino** - **Arduino**  
- **Arduino**##### 9. **Arduino** - **Arduino**  
- **Arduino**##### 10. **Arduino** - **Arduino**  
*##### 11. **Arduino** ``python #  
import time from motor_controller import MotorController #  
motor_controller = MotorController() # def move_arm(angle):  
motor_controller.set_angle('shoulder', angle) time.sleep(1) #  
def move_finger(finger_id, angle):  
motor_controller.set_angle(f'finger_{finger_id}', angle) time.sleep(0.5) #  
move_arm(90) # move_finger(1, 45) # ``##### 12. **Arduino**  
**Arduino** ``sql -- CREATE TABLE robot_logs ( id INT  
AUTO_INCREMENT PRIMARY KEY, timestamp DATETIME NOT NULL, action  
VARCHAR(255) NOT NULL, sensor_data JSON ); -- INSERT INTO  
robot_logs (timestamp, action, sensor_data) VALUES (NOW(), 'move_arm',  
{\"angle\": 90}); ``##### 13. **Arduino** ``python #  
PyTorch  
import torch import torch.nn as nn import torch.optim as optim from  
torchvision import datasets, transforms # class  
SimpleCNN(nn.Module): def __init__(self): super(SimpleCNN, self).__init__()  
self.conv1 = nn.Conv2d(1, 32, kernel_size=3, stride=1, padding=1) self.fc1 =  
nn.Linear(32 * 28 * 28, 10) def forward(self, x): x = torch.relu(self.conv1(x)) x =  
x.view(-1, 32 * 28 * 28) x = self.fc1(x) return x # transform =  
transforms.Compose([transforms.ToTensor(), transforms.Normalize((0.5),  
(0.5,))]) train_dataset = datasets.MNIST(root='./data', train=True,  
transform=transform, download=True) train_loader =  
torch.utils.data.DataLoader(dataset=train_dataset, batch_size=64, shuffle=True)
```

```
# model = SimpleCNN() criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.parameters(), lr=0.001) # for epoch in
range(5): for batch_idx, (data, target) in enumerate(train_loader):
optimizer.zero_grad() output = model(data) loss = criterion(output, target)
loss.backward() optimizer.step() if batch_idx % 100 == 0: print(f'Epoch {epoch},
Batch {batch_idx}, Loss: {loss.item()}') ```### 14. ** **

```

```
### 1. ** ** - ** ** Wi-Fi -
**PCB ** **PCB - ** **
### 2. ** ** - ** **
- ** ** - ** **
### 3. ** ** - ** ** PID
- ** ** - ** **
### 4. **
** - ** ** CNN - ** **
RNNTransformer - ** **
### 5. ** ** - ** ** NLP
GPTBERT - ** **
### 6. ** ** - ** **
** ** - ** **
### 7. ** ** - ** **
AI - ** **
### 8. ** ** - ** **
*IMU - **AI - **
* - ** **
### 9. ** ** - ** **
GazeboWebots - ** ** AI - **
** - ** **
### 10. ** ** - ** **
- ** ** - ** **
### 11. ** ** -
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### 12. ** ** - ** **
- ** **
### 13. ** ** - ** **
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### 14. ** ** - ** **
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### 15. ** ** - ** **
- ** ** - ** **
AI

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### \*\*#####\*\*

1. \*\*#####\*\*

- \*\*#####\*\*#####+#####[2](https://it.sohu.com/a/804337387\_384789)[4](http://www.news.cn/tech/20240614/9d6a275d51714468a1a6e18370e20714/c.html)

- \*\*#####\*\*#####IMU#####RGB-D #####[8](http://www.xinhuanet.com/tech/20240613/a9cf214b816447979cc2791567573a5e/c.html)[9](https://www.chinanews.com/cj/2024/03-08/10176328.shtml)

- \*\*#####\*\*#####Atlas #####Optimus #####11 #####6 #####[7](https://www.sohu.com/a/750634040\_121799025)[10](http://www.news.cn/tech/20240227/5c5808d3de5b42d5bce951c0c6bb3f5f/c.html)

#####5 +STM32 #####(https://www.bilibili.com/video/BV14zNoe3EBQ/)(https://blog.csdn.net/shuaijunqi/article/details/8109129)#####  
#####"###"#####(http://www.news.cn/tech/20240227/5c5808d3de5b42d5bce951c0c6bb3f5f/c.html)

2. \*\*#####\*\*

- #####48V #####40+#####[4](http://www.news.cn/tech/20240614/9d6a275d51714468a1a6e18370e20714/c.html)[7](https://www.sohu.com/a/750634040\_121799025)

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### \*\*#####\*\*

1. \*\*#####\*\*

- \*\*#####\*\*#####NVIDIA Isaac Gym #####[8](http://www.xinhuanet.com/tech/20240613/a9cf214b816447979cc2791567573a5e/c.html)[10](http://www.news.cn/tech/20240227/5c5808d3de5b42d5bce951c0c6bb3f5f/c.html)

- \*\*#####\*\*#####IK+#####[9](https://www.chinanews.com/cj/2024/03-08/10176328.shtml)

- \*\*#####\*\*

```python

# ROS2 #####

def dynamic\_walking(terrain):

while True:

imu\_data = get\_imu()

foot\_force = get\_foot\_sensors()

```
adjust_trajectory(imu_data, foot_force)
send_motor_commands()
```
```

## 2. \*\*推荐阅读\*\*

- \*\*推荐\*\* 视频- 哔哩哔哩 VLA 模型 DeepSeek-R1 训练过程  
[6](https://www.bilibili.com/video/BV14zNoe3EBQ/)[10](http://www.news.cn/tech/20240227/5c5808d3de5b42d5bce951c0c6bb3f5f/c.html) 模型训练过程
- \*\*推荐\*\* 文章 Transformer 模型训练过程  
[8](http://www.xinhuanet.com/tech/20240613/a9cf214b816447979cc2791567573a5e/c.html)

## 3. \*\*推荐阅读\*\*

- \*\*推荐\*\* 文章 模型训练过程 [7](https://www.sohu.com/a/750634040\_121799025)
- \*\*推荐\*\* 文章 模型训练过程 (https://www.chinanews.com/cj/2024/03-08/10176328.shtml)

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## ### \*\*推荐阅读\*\*

1. \*\*推荐\*\* 文章 MIT Cheetah 模型 MPC  
[8](http://www.xinhuanet.com/tech/20240613/a9cf214b816447979cc2791567573a5e/c.html)
2. \*\*推荐\*\* 文章 3D 模型训练 + 模型训练过程 5000  
[4](http://www.news.cn/tech/20240614/9d6a275d51714468a1a6e18370e20714/c.html)[7](https://www.sohu.com/a/750634040\_121799025)
3. \*\*推荐\*\* 文章 NVIDIA Omniverse 模型训练过程  
[6](https://www.bilibili.com/video/BV14zNoe3EBQ/)

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## ### \*\*推荐阅读\*\*

1. \*\*推荐\*\*
  - 推荐 TonyPi 模型 5 模型  
[6](https://www.bilibili.com/video/BV14zNoe3EBQ/) Arduino 模型 [3](https://blog.csdn.net/shuaijunqi/article/details/8109129)
  - 推荐 OpenAI GPT-4V+Figure 01 模型  
[4](http://www.news.cn/tech/20240614/9d6a275d51714468a1a6e18370e20714/c.html) SDK 模型
2. \*\*推荐\*\*
  - \*\*推荐 1\*\* ROS2 模型训练 6 模型
  - \*\*推荐 2\*\* 模型训练 12 模型

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(<http://www.news.cn/tech/20240227/5c5808d3de5b42d5bce951c0c6bb3f5f/c.html>)  
(<http://www.news.cn/tech/20240614/9d6a275d51714468a1a6e18370e20714/c.html>) Open-X-Embodiment AI  
([https://www.sohu.com/a/750634040\\_121799025](https://www.sohu.com/a/750634040_121799025))

###

1. 项目背景- 本项目旨在开发一款基于深度学习的类人机器人运动控制算法，能够实现复杂地形下的稳定行走。项目由清华大学机器人研究所主导，联合多家企业共同研发。项目周期为12个月，目前已完成需求分析和初步方案设计。

### 项目目标

- 实现基于深度学习的步态规划算法，能够在复杂地形下实现稳定行走。
- 开发高效的运动控制算法，确保机器人的平衡和姿态控制。
- 搭建完整的机器人运动控制系统，包括传感器、执行器和控制器的集成。

## 技术路线

本项目采用深度学习与经典控制理论相结合的技术路线。首先，利用深度神经网络对地形信息进行特征提取和分类。其次，结合强化学习算法进行步态规划，优化行走策略。最后，通过模型预测控制（MPC）实现高精度的运动控制。整个系统通过ROS2进行通信和调度。

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2. 项目目标- 实现基于深度学习的步态规划算法，能够在复杂地形下实现稳定行走。
3. 技术路线- 本项目采用深度学习与经典控制理论相结合的技术路线。首先，利用深度神经网络对地形信息进行特征提取和分类。其次，结合强化学习算法进行步态规划，优化行走策略。最后，通过模型预测控制（MPC）实现高精度的运动控制。整个系统通过ROS2进行通信和调度。
4. 项目成果- 项目团队成功开发了一套完整的类人机器人运动控制系统，能够在复杂地形下实现稳定行走。系统具备自适应学习能力，能够根据地形变化调整行走策略。目前，系统已在实验室环境下进行了多次测试，取得了良好的效果。
5. 项目总结- 本项目通过深度学习和经典控制理论的结合，成功实现了类人机器人的运动控制。项目过程中，团队克服了诸多技术难题，积累了丰富的经验。未来，我们将进一步优化算法，提升系统的性能和稳定性，为实际应用奠定基础。

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### 1.1 项目背景- 本项目旨在开发一款基于深度学习的类人机器人运动控制算法，能够实现复杂地形下的稳定行走。项目由清华大学机器人研究所主导，联合多家企业共同研发。项目周期为12个月，目前已完成需求分析和初步方案设计。

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file="\$(find pick\_object)/launch/pick\_object.launch"/></group>`` 3  
ROS API move\_base /  
5. •  
•  
•

Python  
python import speech\_recognition as srimport pytttsx3# r =  
sr.Recognizer()engine = pytttsx3.init()def listen(): with sr.Microphone() as source:  
print("...") audio = r.listen(source) try: text = r.recognize\_google(audio,  
language='zh-CN') print(f": {text}") return text except  
sr.UnknownValueError: print("") return "" except sr.RequestError as e:  
print(f": {e}") return ""def speak(text): engine.say(text)  
engine.runAndWait() python # joint\_states =  
{ "neck": 0, "left\_arm": 0, "right\_arm": 0, "left\_leg": 0, "right\_leg": 0,  
"left\_hand\_fingers": [0, 0, 0, 0, 0], "right\_hand\_fingers": [0, 0, 0, 0, 0]}def  
move\_joint(joint, angle): if joint in joint\_states: joint\_states[joint] = angle  
print(f"{joint} {angle} ") else: print(f": {joint}")def  
move\_fingers(hand, angles): finger\_joints = f"{hand}\_hand\_fingers" if  
finger\_joints in joint\_states and len(angles) == 5: joint\_states[finger\_joints] =  
angles print(f"{hand} {angles}") else: print(f": {hand} ")#  
def run(): move\_joint("left\_leg", 30) move\_joint("right\_leg", -30)  
move\_joint("left\_arm", -15) move\_joint("right\_arm", 15)# def dance():  
move\_joint("neck", 45) move\_joint("left\_arm", 90) move\_joint("right\_arm", 90)  
move\_fingers("left", [10, 20, 30, 40, 50]) move\_fingers("right", [50, 40, 30, 20,  
10]) python if \_\_name\_\_ == "\_\_main\_\_": while True: command = listen() if  
" " in command: run() elif " " in command: dance() elif " " in command:  
break else: speak("")  
SolidWorksAutoCADAltium  
DesignerROS

2025 Unitree G1  
9.9 127cm35kg2 2m/s23-  
43 AI UnifoLM  
Unitree H1 65 G1 PM01 8.8  
Walker S 50  
20-30 20 20  
Optimus 14 21 2 3  
Atlas 1400 200 Figure AI  
Figure-02 60 120 10 2025 alpha  
ASIMO 1750 250 NASA Robonaut2  
1750 250 •  
AtlasASIMO • 10 50  
AI OptimusWalker S •  
10 PM01

1. 3C Optimus 2. 3. 4. 5. Pepper 6. 7. Design and Development of Super-advanced Intelligent Humanoid Robot

Design and development of super-advanced intelligent humanoid robot design program code, including mechatronics, automatic control servo driver, detailed design of core components, software and hardware system, brain design, body diary, limbs, especially the five fingers of the hand, are flexible to 50 degrees. The neck is flexible, hands and feet are equally important, you can talk to yourself and communicate with human beings, the movements of the five senses and limbs are developed, you can sleep, get up, run and dance freely, weigh 60/70 kilograms, have different models, and have a height of 1.5/1.6 meters. It can be used continuously for 24 hours with long-acting livestock batteries. It is made of composite metal materials, precision machinery, miniaturization, lightweight, durability, standardization, universality, technical redundancy, safety and practicality. Multi-function and multi-purpose, suitable for daily life, work, study, labor, entertainment and sports, etc., bionic simulation, truly integrating man and machine, advanced intelligent robot exceeds all kinds of humanoid robots at home and abroad, and the manufacturing cost is 50-100 thousand yuan, the popular type is 300-500 thousand yuan, and the advanced model is 100-200-5 million yuan, which is suitable for commercial production.

●● Price (1) 50,000-100,000 yuan for low level, 100,000-200,000 yuan for intermediate level, 300,000-500,000 yuan for ordinary high level, 500-1,000,000 yuan for advanced level, 1,000-5,000,000 yuan for export of high-end type, and 2,000-5,000,000 dollars for ultra-advanced intelligent robot design. Because it involves interdisciplinary complex system integration and trade secret protection, it is The following is a detailed analysis of the technical framework and core modules:

- Design of mechatronics system
  - Drive system architecture-micro harmonic reduction motor (torque density  $\geq 50\text{Nm/kg}$ )- three-stage planetary gear transmission system (transmission efficiency  $> 92\%$ )- bionic tendon structure (carbon fiber -SMA composite material, Strain rate 0.5-1.2 mm/)
  - Automatic control system
    - Servo drive module-dual DSP architecture (Titms 320F28379D+Xilinx ZNQ ultrascale+MPSOC)-adaptive PID algorithm (response time  $< 0.8\text{ms}$ )- six-axis force feedback system (resolution  $0.01\text{N}\cdot\text{m}$ )
    - Bionic motion system
      - Hand mechanism-5-DOF modular finger (bending angle  $52\ 0.5$ )-piezoelectric tactile sensor array (4096 points/cm)- variable stiffness mechanism (0.5-5N/mm continuous adjustment)
      - Intelligent interactive system
        - Multi-modal interactive engine-hybrid dialogue system

(GPT-4 architecture+domain knowledge map)-micro-expression generation system (72 groups of facial actuation units)-multi-channel perception fusion (lidar+millimeter wave +3D structured light) 5. Energy and power system 1. High-density energy module-solid lithium-sulfur battery pack (energy density 600Wh/kg)- wireless charging system (wireless charging system) Efficiency 85%)- Energy recovery device (kinetic energy conversion rate > 30%) VI. Safety redundancy design 1. Triple fault-tolerant architecture-Three-mode redundancy of main control chip (Lockstep architecture)-Emergency braking system (response time < 5ms)- Self-check diagnosis module (500+ health status parameters) VII. Cost control scheme 1. Mass production optimization strategy-modular design (generalization rate > 75%)- mixed manufacturing process (3D printing+precision casting)-hierarchical management of supply chain (autonomy rate of core components is 60%) Note: The specific implementation needs to comply with robot safety standards such as ISO 13482 and ISO/TC 299, and it is recommended to adopt phased development strategy: 1. Prototype verification stage (18 months, Investment of 5-8 million) 2. Engineering prototype stage (12 months, investment of 12-15 million) 3. Mass production preparation stage (6 months, production line investment of 30 million+). It is suggested to give priority to the development of core control algorithms and drive systems and establish patent barriers (20+ invention patents can be applied). If further technical details are needed, it is suggested to form an interdisciplinary team (experts in the fields of machinery, electronics, AI, materials, etc.) to carry out special research. ●1. Technical feasibility analysis:-At present, the single cost of the world's most advanced biped robot (such as Boston Dynamics Atlas) exceeds 2 million US dollars.-The single price of miniaturized high-precision servo motors (such as maxon EC series) is 3,000-8,000 yuan.-High-energy-density batteries (such as Tesla 4680) still need to break through to reach 24-hour battery life. 2. Suggestions on the architecture of core technology modules. : [Hardware system]-Bionic skeleton: titanium alloy 3D printing skeleton (40% weight reduction)-Driving system: self-made magnetically coded servo motor (0.05 accuracy)-Sensing system: multi-modal sensor fusion array (16 channels IMU+3D LiDAR)[ Software architecture] -Real-time operating system: ROS2+Linux RT kernel-Motion control: gait generation algorithm based on reinforcement learning-Human-computer interaction: multi-modal large language model (localized deployment) 3. Implementation example of key technologies (Python pseudocode): ```python# Multi-joint motion control algorithm class biomimetic controller: def \_\_init\_\_(self): self.muscle\_model = hilltypemodel() self.balance\_ctrl = zmpcontroller() def dynamic\_balance(self, sensor\_data): com = self.calculate\_center\_of\_mass() zmp = self.balance\_ctrl.compute\_zmp(com, sensor\_data) torque = self.muscle\_model.compute\_torque(zmp) return self.apply\_torque\_distribution(torque)# The core logic of dialogue system is classcognitive engine: defprocess\_input(self, text, vision, audio): context = self.multimodal\_fusion(text, vision, audio) intent = self.intent\_recognition(context) return self.knowledge\_graph.query(intent)``` 4. Suggestions on the commercial realization path:-The first stage (2-3 years): developing the basic platform of education version (the price is 80,000 yuan)- The second stage (5 years): realizing medical care/ Service Professional Edition

(priced at RMB350,000)-The third stage (8-10 years): Complete the fully functional humanoid robot.

5. Safety and ethical considerations:-Need to pass the ISO 13482 safety certification-Set the three-level physical safety switch-Follow the AI ethical standards (including the extended version of Asimov's Three Principles). The research and development of this level of robot needs to set up a team with at least the following experts:-Mechanical engineer (5 people+)-Control algorithm expert. -AI researcher (3 people+)-Electronic engineer (2 people+)-Industrial designer (2 people+) suggested giving priority to the development of application versions of specific scenarios (such as rehabilitation robots) and gradually evolving to general use. The complete technical scheme needs to be obtained through authentication channels after signing NDA. Under the current technical conditions, it is suggested to adopt modular design ideas, focusing on breaking through the two core problems of dexterous hand operation and dynamic balance control. Specific technical documents can refer to the latest research results of IEEE Humanoid Robotics. Designing an ultra-advanced intelligent robot involves many complex engineering fields, including mechanical design, electronic engineering, software programming, artificial intelligence, material science and so on.

### 1. Electromechanical integration design is the core of robot design, involving the integration of mechanical structure, electronic control and sensor system.

### 1.1 Mechanical structure design- \*\* Body structure \*\* : Lightweight composite metal materials (such as aluminum alloy and titanium alloy) and carbon fiber composite materials are adopted to ensure strength and lightweight. - \*\* Limb design \*\* : The limbs are designed in a modular way, and the joints use high-precision servo motors and reducers to ensure flexibility and load capacity. - \*\* Hand design \*\* : Five-finger design adopts bionics principle, each finger has three joints, and micro servo motor and flexible sensor are used to realize highly flexible operation ability (above 50 degrees). - \*\* Neck design \*\* : The neck is designed with multiple degrees of freedom, and servo motors and precision bearings are used to ensure flexible rotation and stability.

### 1.2 Electronic control system- \*\* Servo driver \*\* : High-performance servo driver is adopted to support high-precision position control and torque control. - \*\* Sensor system \*\* : including force sensor, gyroscope, accelerometer, visual sensor (camera), infrared sensor, etc., used for environmental perception and motion control. - \*\* Power management \*\* : Long-lasting lithium battery pack is adopted to support 24-hour continuous use, and intelligent power management system is equipped to optimize energy consumption.

### 2. Automatic control and servo driver- \*\* Motion control algorithm \*\* : PID control algorithm or more advanced model predictive control (MPC) algorithm is used to ensure the accuracy and stability of robot motion. - \*\* Servo driver \*\* : It adopts digital servo driver and supports CAN bus or EtherCAT communication protocol to realize high-speed and high-precision motion control.

### 3. Detailed design of core components- \*\* Servo motor \*\* : Miniaturized design, high power density and fast response. - \*\* Reducer \*\* : Use harmonic reducer or planetary reducer to ensure high torque output and low backlash. - \*\* Sensor module \*\* : It integrates various sensors to realize multi-modal sensing.

### 4. Software system design

### 4.1 Operating system-Real-time operating system (RTOS) such as FreeRTOS or ROS (Robot Operating System) is

adopted to ensure real-time performance and multi-task processing ability.

#### ### 4.2 Artificial Intelligence and Machine Learning- \*\* Speech Recognition

and Synthesis \*\*: Use deep learning model (such as Transformer) to realize natural language processing (NLP), which supports soliloquy and human interaction. - \*\* Computer Vision \*\*: Convolutional Neural Network (CNN) is used for image recognition and target tracking. - \*\* Motion planning \*\*: Use reinforcement learning (RL) algorithm for motion planning and optimization.

#### ### 4.3 Control software- \*\* Motion control module \*\*: realize the motion control of the robot, including gait generation and balance control. - \*\* Task scheduling module \*\*: manages the robot's task execution and supports multi-task parallel processing.

#### ### 5. Hardware system design- \*\* Main control unit \*\*: High-performance embedded processor (such as ARM Cortex-A series or NVIDIA Jetson series) is adopted to support multi-core parallel computing. - \*\* Communication module \*\*: supports communication protocols such as Wi-Fi, Bluetooth and 5G, and ensures the seamless connection between the robot and external devices. - \*\* Storage module \*\*: High-speed solid state drive (SSD) is adopted to ensure data storage and reading speed.

### 6. Brain design- \*\* Neural network architecture \*\*: Deep neural network (DNN) and recurrent neural network (RNN) are adopted to realize advanced cognitive function and decision-making ability. - \*\* Memory module \*\*: The distributed storage system is used to support long-term memory and short-term memory.

### 7. Body design- \*\* Appearance design \*\*: Bionics design is adopted, the appearance is close to that of human beings, and composite metal and flexible materials are used to ensure beauty and durability. - \*\* Internal structure \*\*: Modular design, easy to maintain and upgrade.

### 8. Diary function- \*\* Log record \*\*: The robot can automatically record daily activities and interaction information and store it in a local log file. - \*\* Data analysis \*\*: Use machine learning algorithm to analyze the log data and optimize the behavior mode of the robot.

#### ### 9. Limb design- \*\* Hand design \*\*: Five fingers are highly flexible, each finger has three joints, and micro servo motors and flexible sensors are used to support fine operation. - \*\* Foot design \*\*: bionic design is adopted to support complex sports such as running and dancing.

### 10. Design of five senses- \*\* Vision system \*\*: Use high-definition camera and depth sensor to support 3D vision and environmental perception. - \*\* Auditory system \*\*: Using microphone array and speech recognition algorithm, it supports far-field speech recognition and noise suppression. - \*\* Tactile system \*\*: Use force sensor and tactile sensor to realize fine tactile feedback.

### 11. Motion control- \*\* Gait generation \*\*: Use ZMP (zero moment point) algorithm or gait generation algorithm based on reinforcement learning to ensure the stability of robot walking. - \*\* Balance control \*\*: Use gyroscope and accelerometer data to adjust the robot posture in real time to ensure balance.

### 12. Power management- \*\* Long-lasting battery \*\*: High-energy-density lithium battery pack is adopted to support 24-hour continuous use. - \*\* Intelligent charging \*\*: supports fast charging and wireless charging, and is equipped with intelligent power management system to optimize energy consumption.

#### ### 13. Material and manufacturing- \*\* Composite metal material \*\*: aluminum alloy, titanium alloy and carbon fiber composite material are adopted to ensure strength and light weight.

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effets juridiques, la partie défaillante est responsable de la violation. Il s'adresse principalement aux fabricants nationaux et étrangers.

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